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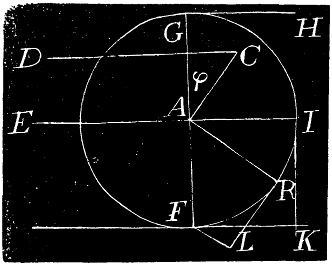
NOTE, BY THE EDITOR.—As the answer (p. 127, Vol. III.) to the query, "Which is the most effective; a brake applied at the top, or side of a car wheel in motion?" has been called in question, and a demonstration is demanded, the following argument is submitted.

If the velocity of a moving train is diminished by the pressure of a brake on the verge of a wheel, the force applied by the brake is manifested, either in the friction developed between the periphery of the wheel and the *track* or as pressure against the head of the piston, through the medium of a crank, or both. Hence the action of the brake in arresting the motion of the train may be regarded as that of a *lever*, either straight or bent.



Let A represent the center of the wheel, or axle, R, any point on its circumference where the brake is applied, and also = the friction produced by the brake; F, the point of contact between the wheel and track, and also = the friction at that point; $AC = c$, the length of the crank, $AF = AR = r$, the radius of the wheel, and φ = the angle which the crank makes with a vertical through A.

Then, if the force applied through the brake is manifested by the friction developed at F, we have a bent lever, RAF, of the first *order*, A being the fulcrum, F, the power and R, the force, or resistance. Now, when the power, fulcrum and resistance are *not* in the same straight line, the power and resistance are "as the straight lines drawn from the fulcrum perpendicular to the respective directions in which the power and resistance take effect."—Brande. Therefore, because AF and AR are the straight lines drawn from the fulcrum at right angles to the respective directions in which F and R "take effect", when these forces are in equilibrium we must have

$$rR = rF, \text{ and } \therefore R = F. \qquad (1)$$

If the force applied to the brake is manifested in pressure on the head of the piston, it may also be considered as that of a lever, the axle being the fulcrum, the force exerted horizontally by the piston, the power, and the friction produced by the brake, the resistance. In this case, as the crank is alternately above and below the axle, the lever is alternately of the first and third order; and because the power acts horizontally and is applied at the distance c from the fulcrum, when the power and resistance are in equilibrium, we shall have

$$Pc \cos \varphi = rR. \qquad (2)$$

Now if we substitute F for R in (2), because R represents any point on the periphery of the wheel, the equation will still be true; so that in this case also, $R = F$. But for the same track and train, F may be considered constant; therefore R is constant, that is, a brake is equally effective whether applied at the top or side of a wheel.

But our correspondent has proved, by experiment, that a force of two pounds at A, in the direction AE, is held in equilibrium by a force of one pound at G in the direction GH; of two pounds at I, in the direction IK, and of about four pounds at R, in the direction RL; whence he concludes that the effect of the brake to arrest the motion of the train must depend on its position relative to the point of contact between the wheel and rail.

In the first of the experiments above named we have a lever of the second order; resistance at G, power at A, and fulcrum at F; the experiment therefore does not apply to the case under consideration, for no amount of *pressure* at G can prevent a force at A, in the direction AE, from producing rotation about the point F.

In the second experiment we have a lever of the first order, fulcrum at A; consequently if the weight of the wheel and the power at I are sufficient to develop two pounds of friction at F, the forces will be in equilibrium as shown by the experiment, but not otherwise.

In the third experiment, we must again regard F as the fulcrum, and consequently the lever will be of the first order; therefore, when the forces at A and R are in equilibrium they must have the proportion of FL to FA.

An analysis of the experiments therefore shows, that the *first* is not applicable; that the *second* confirms Eq. (1) for the point I, and that the *third* proves, what is otherwise apparent, that a brake applied at F would be useless if applied to prevent rotation about the point F. It is apparent, however, that if rotation abont A is prevented, no rotation about F can occur, and hence the brake is only used to prevent rotation about A; and for that purpose, it has been shown, its position, with respect to the point F, is immaterial.

A QUESTION AND ITS SOLUTION.

BY GEORGE EASTWOOD, SAXONVILLE, MASS.

Question. — When only the four sides of a quadrangle are given, how may it be known that the figure can be circumscribed by a circle?

Solution.—Let $ABCD$ be a quadrangle whose sides AB, BC, CD, DA, are known by measurement. Produce the opposite sides AB, DC, to meet in the point E, and the opposite sides DA, CB, to meet in the point F.